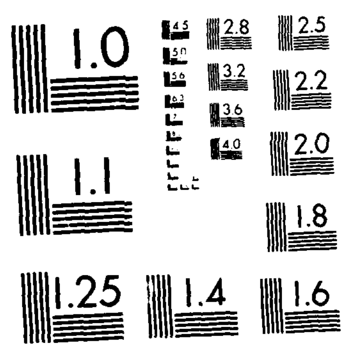
AD-A195 693 PROCESSING TECHNOLOGY RESEARCH IN COMPOSITES(U) 1/1
RENSSELAER POLYTECHNIC INST TROY NY R J DIEFENDORF
31 DEC 87 AFOSR-TR-88-0669 AFOSR-87-0053
UNCLASSIFIED F/G 11/4 NL


1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0

DTIC FILE COPY

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE

(2)

REPORT DOCUMENTATION PAGE

AD-A195 693

1b. RESTRICTIVE MARKINGS	None
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE	
3. DISTRIBUTION/AVAILABILITY OF REPORT	Unlimited Distribution
4. PERFORMING ORGANIZATION REPORT NUMBER(S)	None
5. MONITORING ORGANIZATION REPORT NUMBER(S)	AFOSR-TR- 88-0669
6a. NAME OF PERFORMING ORGANIZATION	Rensselaer Polytechnic Institute
6b. OFFICE SYMBOL (If applicable)	
6c. ADDRESS (City, State and ZIP Code)	Troy, New York 12180-3590
7a. NAME OF MONITORING ORGANIZATION	Air Force Office of Scientific Research
7b. ADDRESS (City, State and ZIP Code)	Bldg 410 Bolling AFB DC 20332-6448
8a. NAME OF FUNDING/SPONSORING ORGANIZATION	Air Force Office of Scientific Research
8b. OFFICE SYMBOL (If applicable)	NA
8c. ADDRESS (City, State and ZIP Code)	Bld 410 BAFB D.C. 20332-6448
9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER	AFOSR-87-0053

10. SOURCE OF FUNDING NOS.

PROGRAM ELEMENT NO.	PROJECT NO.	TASK NO.	WORK UNIT NO.
61102F	2303	C1	

11. TITLE (Include Security Classification)	Processing Technology Research in Composites
12. PERSONAL AUTHOR(S)	Russell Judd Diefendorf
13a. TYPE OF REPORT	Final
13b. TIME COVERED	FROM 10/1/86 TO 9/30/87
14. DATE OF REPORT (Yr., Mo., Day)	1987 December 31
15. PAGE COUNT	7 pages
16. SUPPLEMENTARY NOTATION	

17. COSATI CODES

FIELD	GROUP	SUB. GR.

18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)

CVD Furnace, CARBON/CARBON COMPOSITES

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

A state-of-the-art chemical vapor deposition apparatus has been designed and built. A relatively sophisticated control program, with some AI features, is incorporated.

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT	UNCLASSIFIED/UNLIMITED ☒ SAME AS RPT. ☐ DTIC USERS ☐
21. ABSTRACT SECURITY CLASSIFICATION	Unclassified
22a. NAME OF RESPONSIBLE INDIVIDUAL	Dr. Anthony Amos
22b. TELEPHONE NUMBER (Include Area Code)	(202)767-4937
22c. OFFICE SYMBOL	

DD FORM 1473, 83 APR EDITION OF 1 JAN 73 IS OBSOLETE.

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE

AFOSR-TR. 88-0669

INTRODUCTION

Chemical vapor deposition has been used for over fifteen years for depositing carbon matrices in carbon/carbon composites used for reentry nose-tips, rocket nozzle throat inserts, and aircraft brakes. The same technology is appropriate for depositing silicon carbide or other matrices in ceramic-ceramic composites, or ceramic/carbon composites. Furthermore, chemical vapor deposition is a powerful technique for applying the graded oxidation resistant coatings required for carbon/carbon composites in long time oxidizing environments. Modern instrumentation allows many variations in properties to be made which had been impossible in the past. It is for these reasons that we proposed the acquisition of a state-of-the-art Low Pressure Chemical Vapor Deposition Apparatus. (JES)

EQUIPMENT DESCRIPTION

Low pressure chemical vapor deposition apparatus, with state of the art electronics, was ordered from Casey Instruments, West Sand Lake, NY. The furnace is vertically suspended from the horizontal counter surface. The power supplies and optical pyrometer are located underneath the counter, and the pumps are placed in an isolated compartment beneath the electronics.

Four feedback flow controllers are used to control up to four deposition gases in any prescribed manner. A liquid source is available also to provide a deposition gas. The

input for flow control can either be manual or from the IBMPC AT clone controller. The liquid source and associated lines were heated to allow use of condensable gases.

The furnace vacuum chamber has a uniform temperature zone of 6" diameter by 11" long and is capable of achieving 1800°C with 30 kw of power. There are three separate heaters to allow temperature uniformity. Temperature control is by an Ircon pyrometer or 3 thermocouples controlled 3 R.I. SCR Phasers. Control may either be manual or by computer. Power voltage and amperage are to be displayed. Pressure is measured by a MKS gauge and display unit. Pressure is controlled by an additional inert gas flow to the pumps. The pumps are two Welsh Model number 1374B pumps.

The system can be controlled manually or by computer. A sophisticated computer program has been written with AI features for control and operation of the furnace using dual screen displays. Finally, an appropriate warning and alarm system is part of the computer program to analyse for major malfunctions such as pump failure and low water flow.

The change in some of the components reflects the rapid improvements that are occurring in instrumentation.

LOW PRESSURE CHEMICAL VAPOR DEPOSITION APPARATUS

Equipment	Proposed Source
1. Furnace/Vacuum Chamber Usable interior zone. (0.5' Dia. x 1') Temperature (1800°C)	Casey Instruments (West Sand Lake, NY)

2.	Ircon Maxline Pyrometer	Ircon
	Temperature Controller	Research Incorporated
	Micristar Manual and Automatic Temperature Controllers (3)	Research Incorporated
	SCR Power Controllers (3)	Research Incorporated
3.	Power Supplies, 20 kw 5 kw 5 kw	General Electric
4.	Vacuum Pumps (2) 1374B	Welsh
	Pressure Controls (Variable Leak)	MKS
5.	Pressure Gauge and Readout Model 112A	MKS
6.	Feedback Gas Flow Controllers (4)	MKS
	Liquid Source Flow Controller (1) Display Model 147	MKS
7.	Control and Data Handling Computer 12 MHZ, 30 MB, Hard Disk, 1 meg memory, twin display, 1/A Board, A/D Board, Printer	Tute Technology Services
8.	Mass Spectrometer double pump/interface	Sargent Welsh/Varian

PROPOSED RESEARCH

The equipment will be used to develop ceramic matrix composites, and to provide samples for mechanical and environmental evaluation. Potential research areas are:

(1) SiC/SiC composites. Silicon carbide fibers have been available for over five years now. While the SiC fibers have been used to reinforce glass matrices, they have not been incorporated into a more refractory matrix. CVD

apparatus can be used to infiltrate a silicon carbide or other refractory matrix into a silicon carbide fiber preform. The matrix material can be successfully infiltrated throughout the preform and the interface between the silicon fibers and matrix controlled, so that a tough, high strength composite results.

(2) Oxidation resistant carbon/carbon composites. Carbon/carbon composites are tough, relatively high strength materials. They have been successfully protected with coatings for use in short time, high temperature applications such as the space shuttle leading edges. Turbine parts made of carbon/carbon composites would operate at higher temperatures for longer tines. New oxidation protection systems would have to be developed. Low pressure CVD in an attractive method to provide internal oxidation resistance as well as graded surface coatings.

(3) Fracture behavior of ceramic matrix composites. Ceramic materials are many times more limited by their room temperature brittleness than their high temperature performance. The effect of fiber/matrix bonding would be studied on the fracture behavior and fracture toughness of these materials. Other toughening mechanisms would be combined in parallel if possible, to produce still higher fracture toughness in these materials.

(4) Fundamental studies in the CVD of Structural Composites. Most chemical vapor deposition technology has been developed empirically. Little is known about the mecha-

nisms of deposition and the relations among the deposition conditions, structures and properties. This had caused a great problem in the past in that every new part becomes a new project. Scaling up was performed empirically at great cost. Hopefully, this project would provide understanding and modeling required for scale-up, and apply AI for the control of experimental runs.

END
DATED
FILM
8-88
DTIC